



Cambridge International AS & A Level

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PHYSICS

9702/31

Paper 3 Advanced Practical Skills 1

October/November 2023

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You will be allowed to work with the apparatus for a maximum of 1 hour for each question.
- You should record all your observations in the spaces provided in the question paper as soon as these observations are made.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [].

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1	
2	
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This document has **12** pages. Any blank pages are indicated.

You may not need to use all of the materials provided.

- 1** In this experiment, you will investigate an electric circuit.

You have been provided with a wooden strip with wire attached to nails.

- (a)** • Set up the circuit shown in Fig. 1.1.

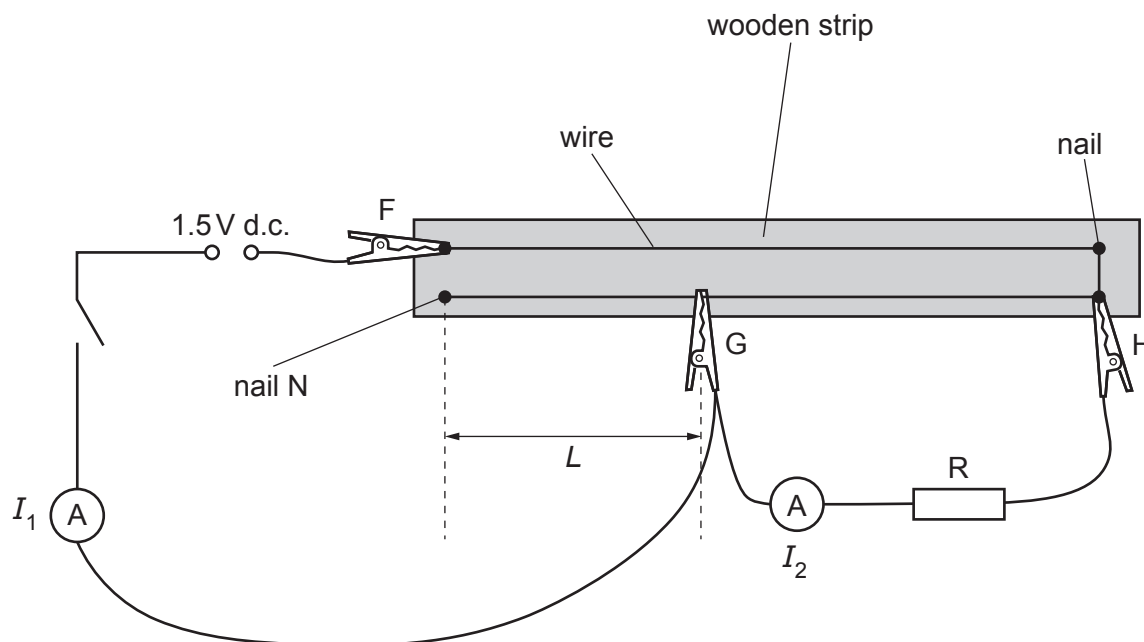


Fig. 1.1

- F, G and H are crocodile clips.

The distance between nail N and G is L , as shown in Fig. 1.1.

Adjust the position of G until L is approximately 40 cm.

- Close the switch.
- Record L and the ammeter readings I_1 and I_2 .

$L =$

$I_1 =$

$I_2 =$

- Open the switch.

[3]

- (b) Change L by adjusting the position of G between N and H. Measure and record L , I_1 and I_2 . Repeat until you have six sets of values of L , I_1 and I_2 .

Record your results in a table. Include values of $\frac{I_2}{(I_1 - I_2)}$ in your table.

[9]

- (c) (i) Plot a graph of $\frac{I_2}{(I_1 - I_2)}$ on the y-axis against L on the x-axis.

[3]

- (ii) Draw the straight line of best fit.

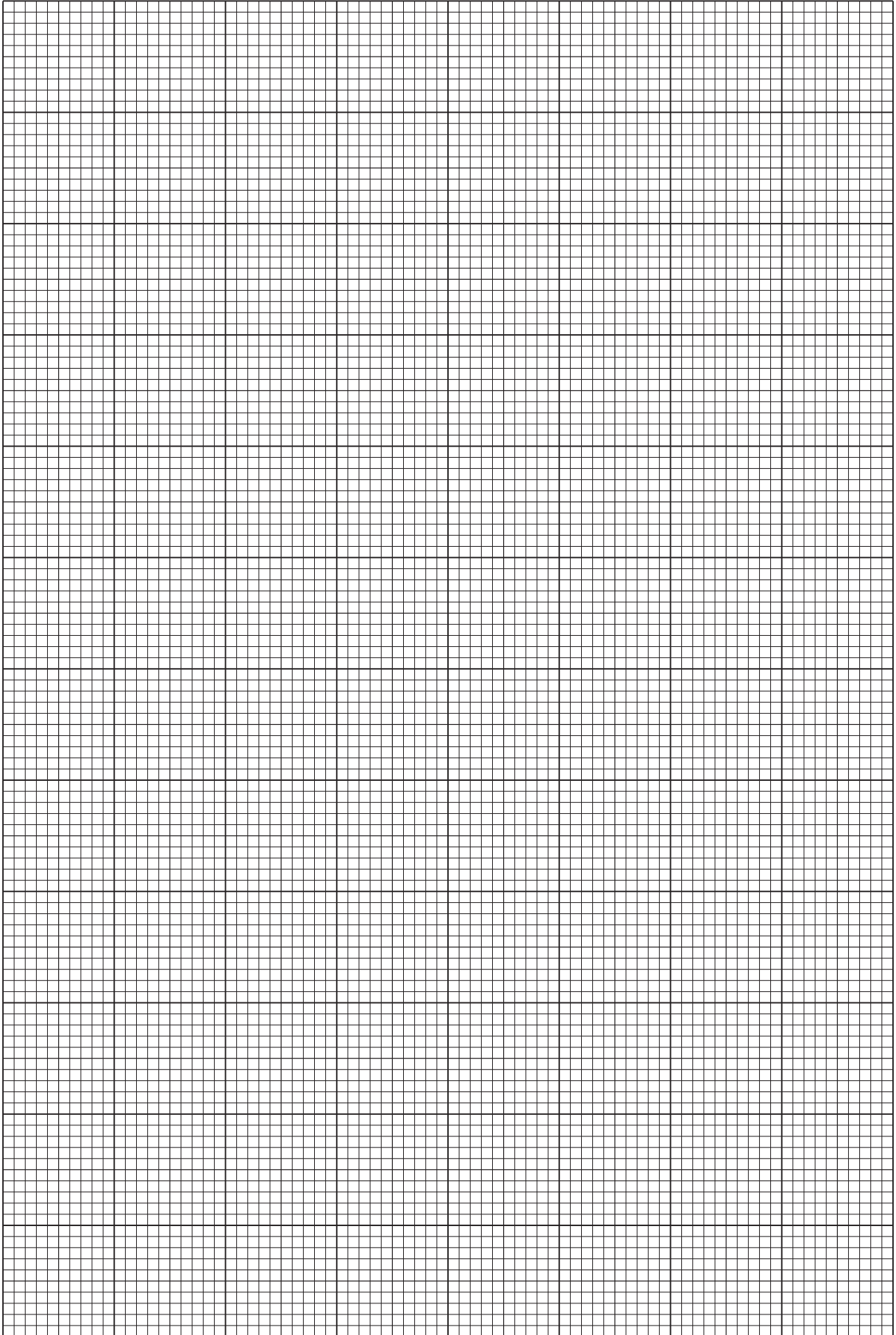
[1]

- (iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...

[2]



(d) It is suggested that the quantities L , I_1 and I_2 are related by the equation

$$\frac{I_2}{(I_1 - I_2)} = PL + Q$$

where P and Q are constants.

Using your answers in (c)(iii), determine the values of P and Q .
Give appropriate units.

$P =$

$Q =$

[2]

[Total: 20]

You may not need to use all of the materials provided.

2 In this experiment, you will investigate the displacement of water from a container.

(a) (i) The apparatus has been set up as shown in Fig. 2.1.

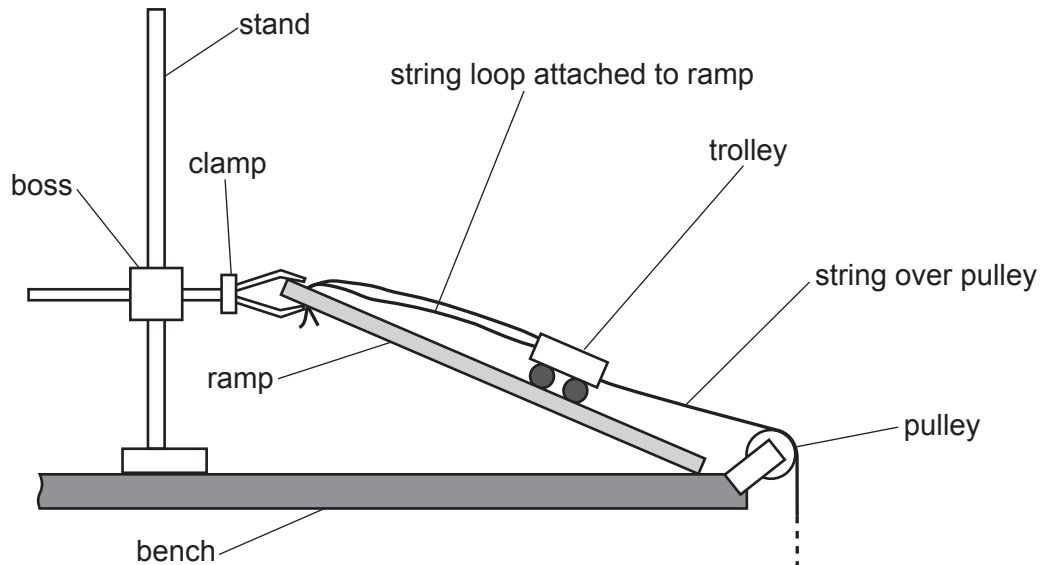


Fig. 2.1

- Ensure that the string passes over the pulley as shown in Fig. 2.1.
- Hang the mass hanger and four slotted masses from the small string loop, as shown in Fig. 2.2.

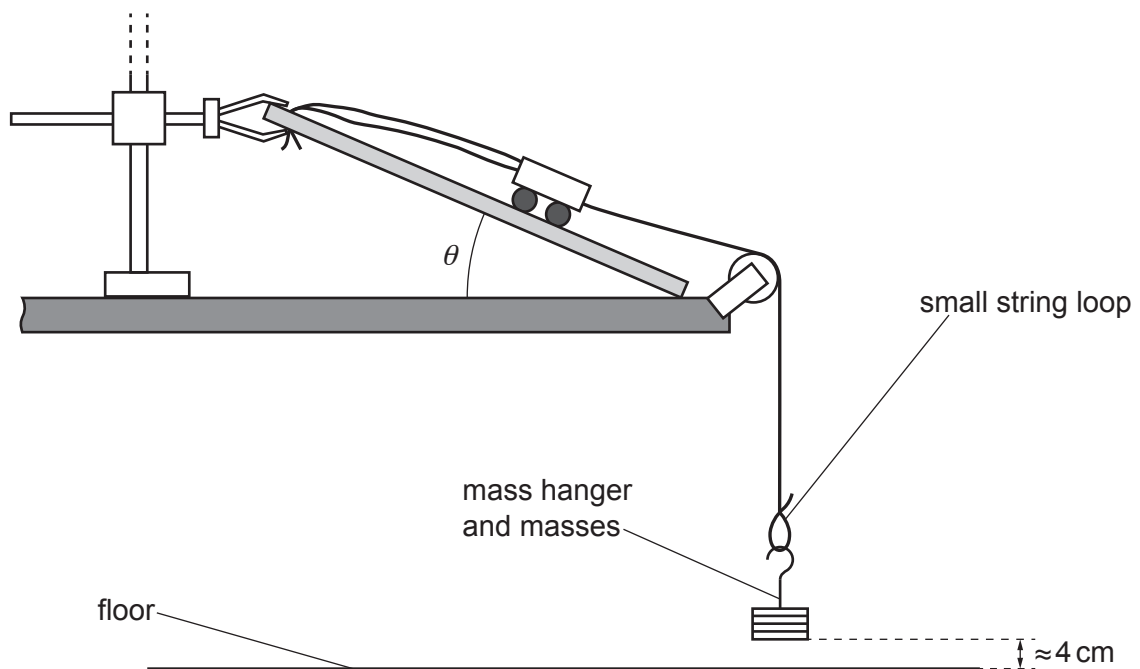


Fig. 2.2

- Adjust the apparatus until the bottom of the masses is approximately 4 cm above the floor.
- Place the two containers so that the mass hanger and masses hang inside the smaller container, as shown in Fig. 2.3.

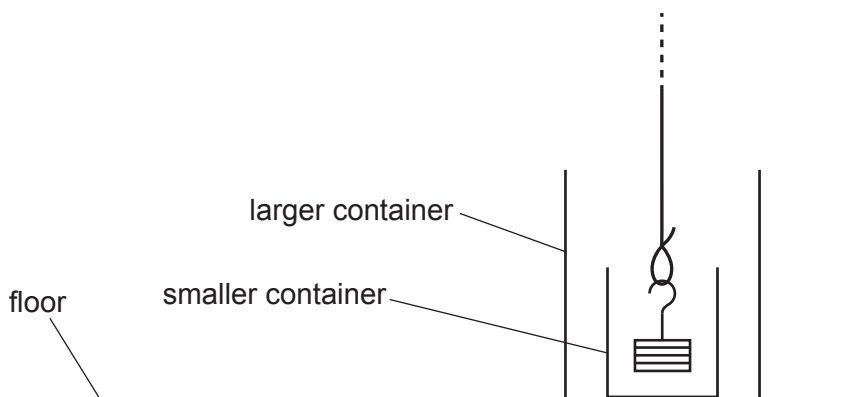


Fig. 2.3

- Pull the trolley up the ramp. Ensure that the string runs over the pulley, and the mass hanger and masses hang above the smaller container. Stop the trolley when its back wheels are approximately 10 cm from the top of the ramp or the small string loop touches the pulley.
- Release the trolley. Ensure that the mass hanger and the masses hang inside the smaller container when the trolley stops.
- Lift the string, mass hanger and masses onto the bench.
- The angle between the ramp and the bench is θ , as shown in Fig. 2.2.

Adjust the apparatus until θ is between 10° and 15° .

- Measure and record θ .

$$\theta = \dots\dots\dots^\circ \quad [2]$$

(ii) Calculate $\cos \theta$.

$$\cos \theta = \dots\dots\dots \quad [1]$$

- (b) (i) • Without spilling any water into the larger container, completely fill the smaller container with water, as shown in Fig. 2.4.

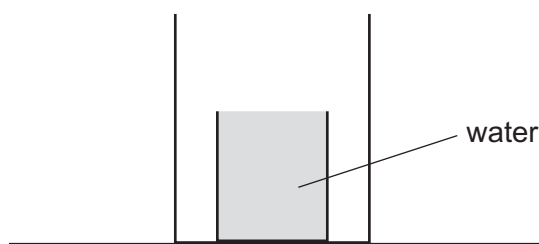


Fig. 2.4

- Hang the mass hanger and masses from the small string loop. Ensure that the string runs over the pulley, and the mass hanger and masses hang above the smaller container.
- Pull the trolley up the ramp. Stop the trolley when its back wheels are approximately 10 cm from the top of the ramp or the small string loop touches the pulley.
- Release the trolley. The masses will fall into the water and water will overflow into the larger container.
- Lift the string, mass hanger and masses onto the bench.
- Measure and record the volume V of water that is now in the larger container.

$V = \dots\dots\dots \text{cm}^3$ [2]

- (ii) Estimate the percentage uncertainty in your value of V . Show your working.

percentage uncertainty = $\dots\dots\dots\%$ [1]

- (c) • Adjust the apparatus until θ is between 25° and 31° .
- Measure and record θ .

$\theta = \dots\dots\dots^\circ$

- Repeat (a)(ii) and (b)(i).

$\cos \theta = \dots\dots\dots$

$V = \dots\dots\dots \text{cm}^3$
[3]

- (d) It is suggested that the relationship between V and θ is

$$V = \frac{k}{\cos \theta}$$

where k is a constant.

- (i) Using your data, calculate two values of k .

first value of k = ...

second value of k = ...

[1]

- (ii) Justify the number of significant figures that you have given for your values of k .

.....

.....

..... [1]

- (e) It is suggested that the percentage uncertainty in the values of k is 15%.

Using this uncertainty, explain whether your results support the relationship in (d).

.....

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..... [1]

- (f) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

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[4]

- (ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

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[Total: 20]

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1 In this experiment, you will investigate the oscillations of a pendulum.

(a) • Set up the apparatus as shown in Fig. 1.1.

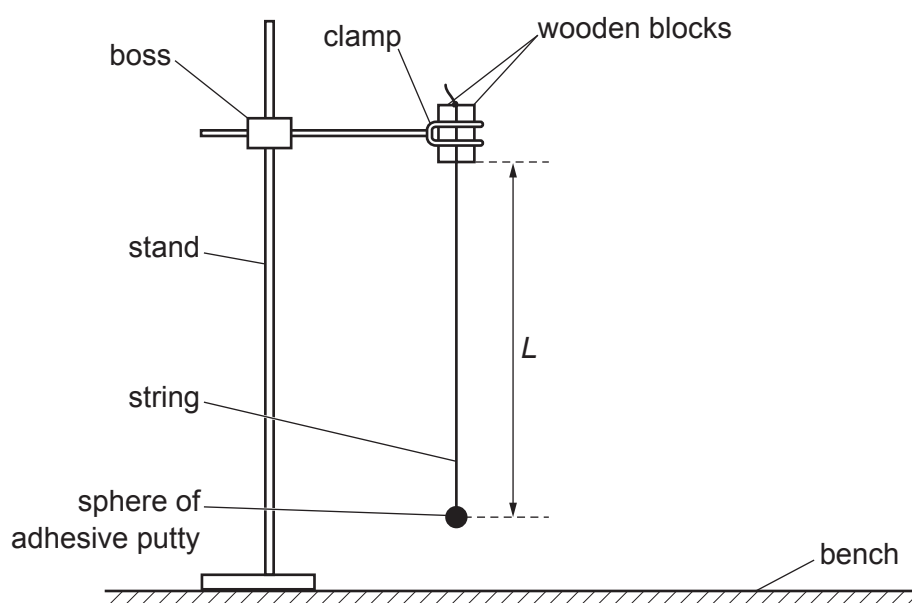


Fig. 1.1

- The length L of the pendulum is the distance between the bottom of the wooden blocks and the centre of the adhesive putty.

Adjust the length of the string so that L is approximately 53 cm.

- Measure and record L .

$L = \dots\dots\dots$ cm [1]

- (b) • Use the second boss to attach the wooden rod to the stand. Adjust the apparatus until the vertical string of the pendulum just touches against the wooden rod, as shown in Fig. 1.2.

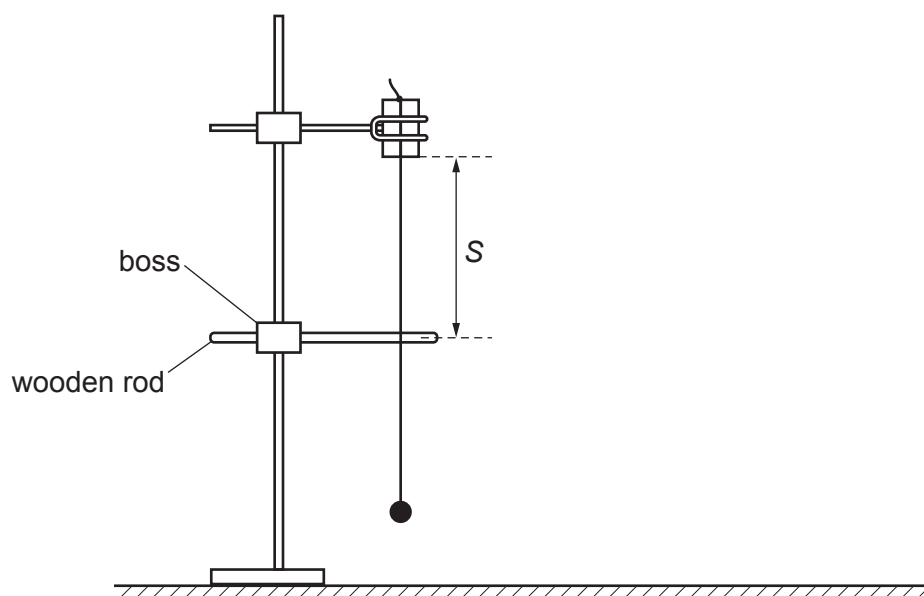


Fig. 1.2

- The distance between the bottom of the wooden blocks and the centre of the wooden rod is S .

Adjust the position of the wooden rod so that S is approximately 36 cm.

- Measure and record S .

$S =$ cm

- Calculate $(L - S)$.

$(L - S) =$ cm

- Move the adhesive putty a small distance so that the string moves away from the wooden rod. Release the adhesive putty. The string hits the rod as the pendulum oscillates.
- Take measurements to determine the period T of the oscillations.

$T =$ s
[2]

- (c) Change S in the range $5.0\text{cm} \leq S \leq 45.0\text{cm}$ by adjusting the position of the wooden rod. Determine T . Repeat until you have six sets of values of S and T .

Record your results in a table. Include values of $\sqrt{(L - S)}$ in your table.

[8]

- (d) (i) Plot a graph of T on the y -axis against $\sqrt{(L - S)}$ on the x -axis.

[3]

- (ii) Draw the straight line of best fit.

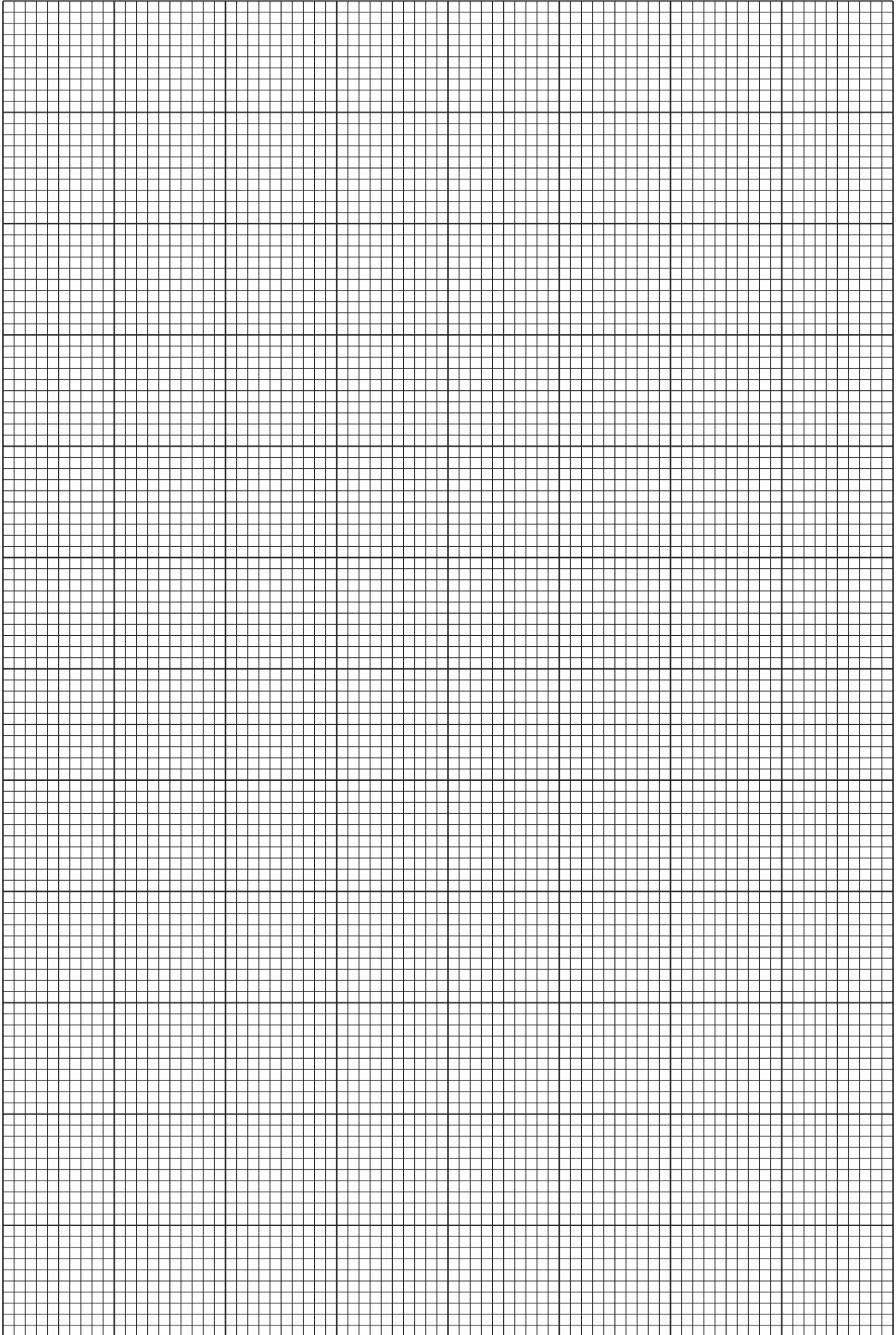
[1]

- (iii) Determine the gradient and y -intercept of this line.

gradient = ...

y -intercept = ...

[2]



- (e) (i) It is suggested that the quantities T , L and S are related by the equation

$$T = A\sqrt{(L - S)} + B$$

where A and B are constants.

Using your answers in (d)(iii), determine the values of A and B .
Give appropriate units.

$A =$

$B =$

[2]

- (ii) Theory suggests that

$$A = \frac{\pi}{\sqrt{g}}$$

where g is the acceleration of free fall.

Use your answer in (e)(i) to determine a value for g .
Give an appropriate unit.

$g =$ [1]

[Total: 20]

You may not need to use all of the materials provided.

2 In this experiment, you will investigate a wooden strip resting at an angle.

(a) (i) • You are provided with a wooden strip, as shown in Fig. 2.1.

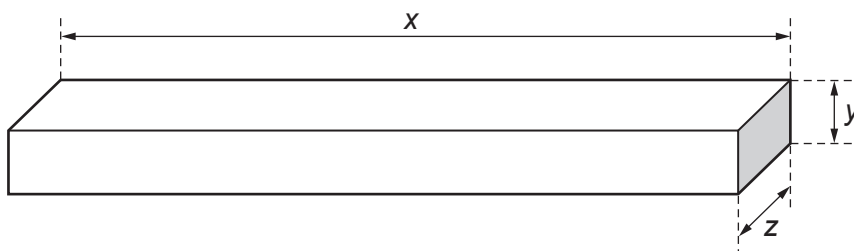


Fig. 2.1 (not to scale)

The dimensions of the strip are x , y and z .

Measure and record x , y and z .

$x =$ m

$y =$ m

$z =$ m

• The volume V of the strip is given by the equation

$$V = xyz.$$

Calculate V .

$V =$ m^3
[2]

(ii) Justify the number of significant figures that you have given for your value of V .

.....
.....
..... [1]

- (b) (i) • Set up the apparatus as shown in Fig. 2.2.

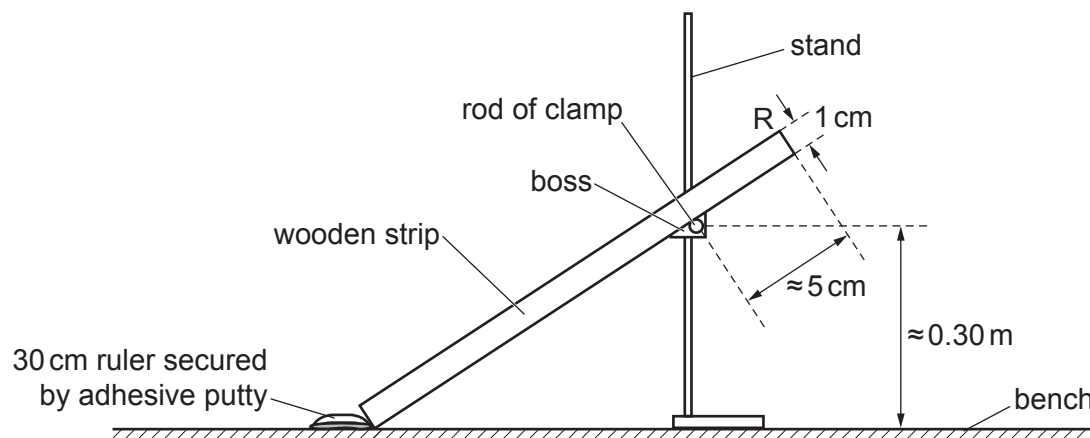


Fig. 2.2 (not to scale)

- Adjust the position of the boss so that the rod of the clamp is approximately 0.30 m above the bench.
- Use some of the adhesive putty to secure the 30 cm ruler to the bench, as shown in Fig. 2.2.
- The raised end of the wooden strip is R, as shown in Fig. 2.2. Place the wooden strip on the rod and adjust the position of the stand so that the distance between the rod and R is approximately 5 cm.
- Use adhesive putty to attach the mass to the wooden strip so that the distance d between the lower end of the wooden strip and the centre of the mass is approximately 0.15 m, as shown in Fig. 2.3.

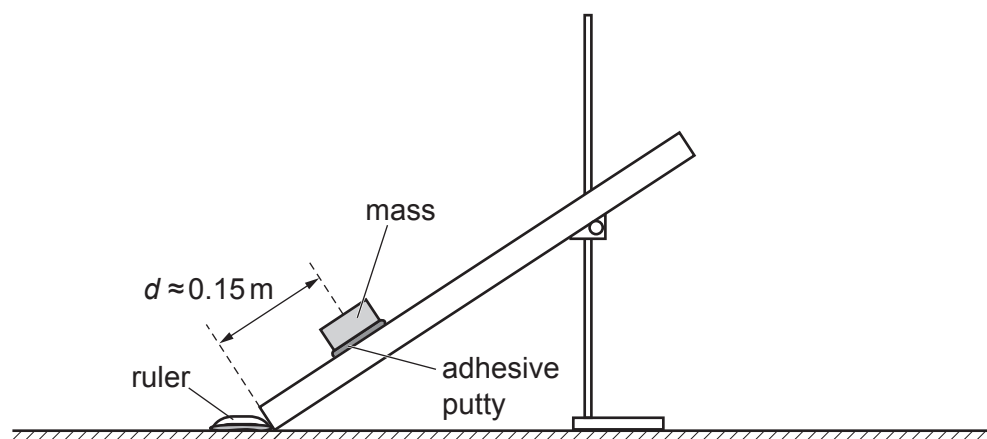


Fig. 2.3

- Measure and record d .

$d = \dots\dots\dots$ m [1]

- (ii) • Use adhesive putty to attach the loop of string at the raised end R of the wooden strip, as shown in Fig. 2.4.

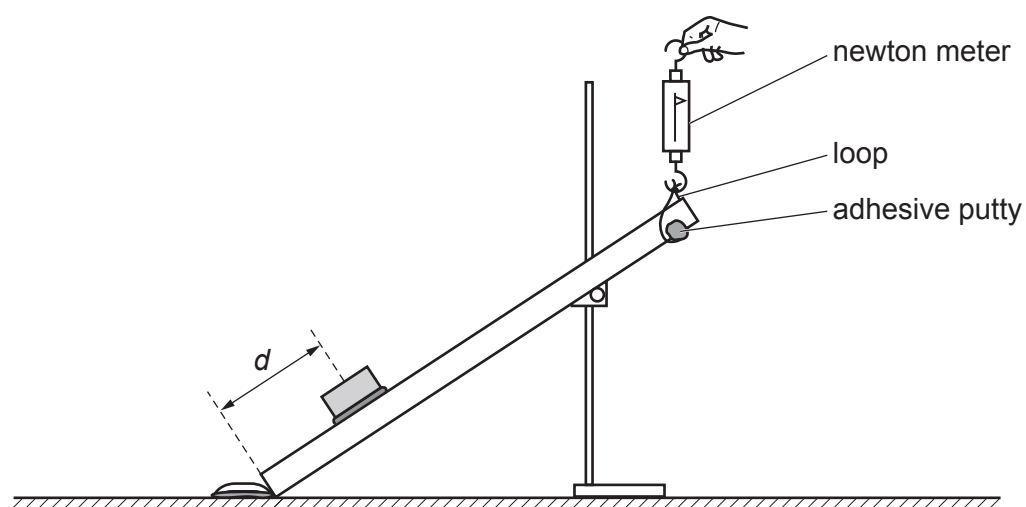


Fig. 2.4

- Use the newton meter to determine the vertical force F needed to just lift the wooden strip from the rod.

$F = \dots\dots\dots$ N [2]

- (iii) Estimate the percentage uncertainty in your value of F . Show your working.

percentage uncertainty = $\dots\dots\dots$ % [1]

- (iv) • Adjust the position of the mass so that d is approximately 0.30 m.
- Measure and record d and F .

$d =$ m

$F =$ N
[2]

- (c) It is suggested that the relationship between F , x and d is

$$Fx = Wd + k$$

where W is the weight of the mass and has the value 0.49 N, and k is a constant.

Using your data, calculate two values of k .

first value of $k =$

second value of $k =$
[1]

- (d) It is suggested that the percentage uncertainty in the values of k is 15%.

Using this uncertainty, explain whether your results support the relationship in (c).

.....

.....

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..... [1]

- (e) Theory suggests that

$$k = \frac{\rho g V x}{2}$$

where g is 9.8 N kg^{-1} and ρ is the density of the wood.

Use your second value of k and values from (a)(i) to determine ρ .
Give an appropriate unit.

$$\rho = \dots\dots\dots [1]$$

- (f) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

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[4]

- (ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

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[Total: 20]

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2 hours

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[Turn over

You may not need to use all of the materials provided.

1 In this experiment, you will investigate an electrical circuit.

(a) • Connect the circuit shown in Fig. 1.1.

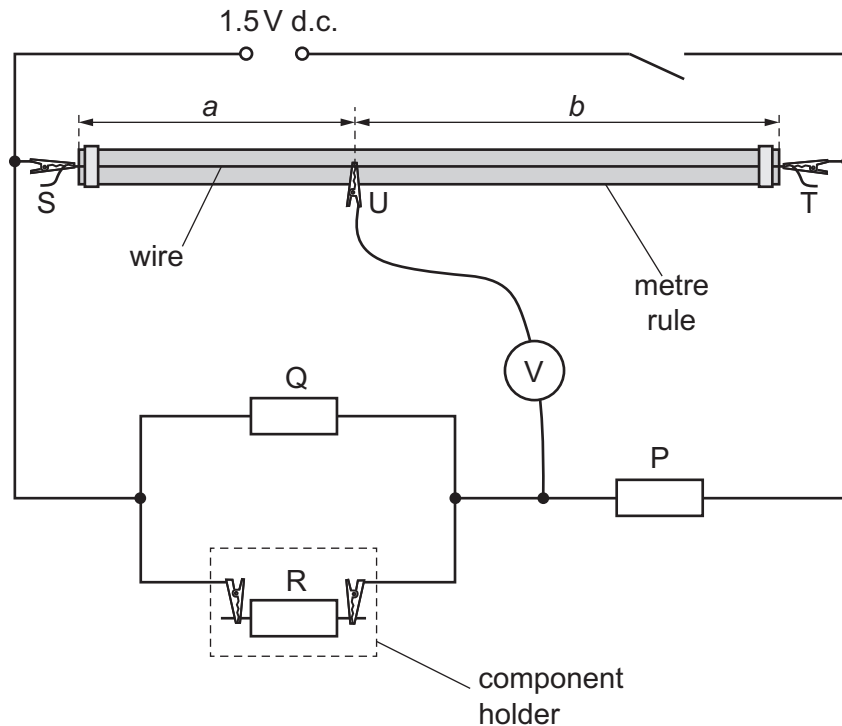


Fig. 1.1

- S, T and U are crocodile clips.

Connect one of the resistors labelled with its resistance in the component holder as resistor R, and record its resistance R .

$R =$

- Close the switch.
- Place U on the wire and adjust its position so that the voltmeter indicates as near to zero as possible.
- The distance between S and U is a and the distance between U and T is b , as shown in Fig. 1.1.

Measure and record a and b .

$a =$

$b =$

- Open the switch.

[2]

- (b) Change R and determine a and b . Repeat until you have six sets of values of R , a and b .

Record your results in a table. Include values of $\frac{1}{R}$ and $\frac{b}{a}$ in your table.

[10]

- (c) (i) Plot a graph of $\frac{b}{a}$ on the y -axis against $\frac{1}{R}$ on the x -axis.

[3]

- (ii) Draw the straight line of best fit.

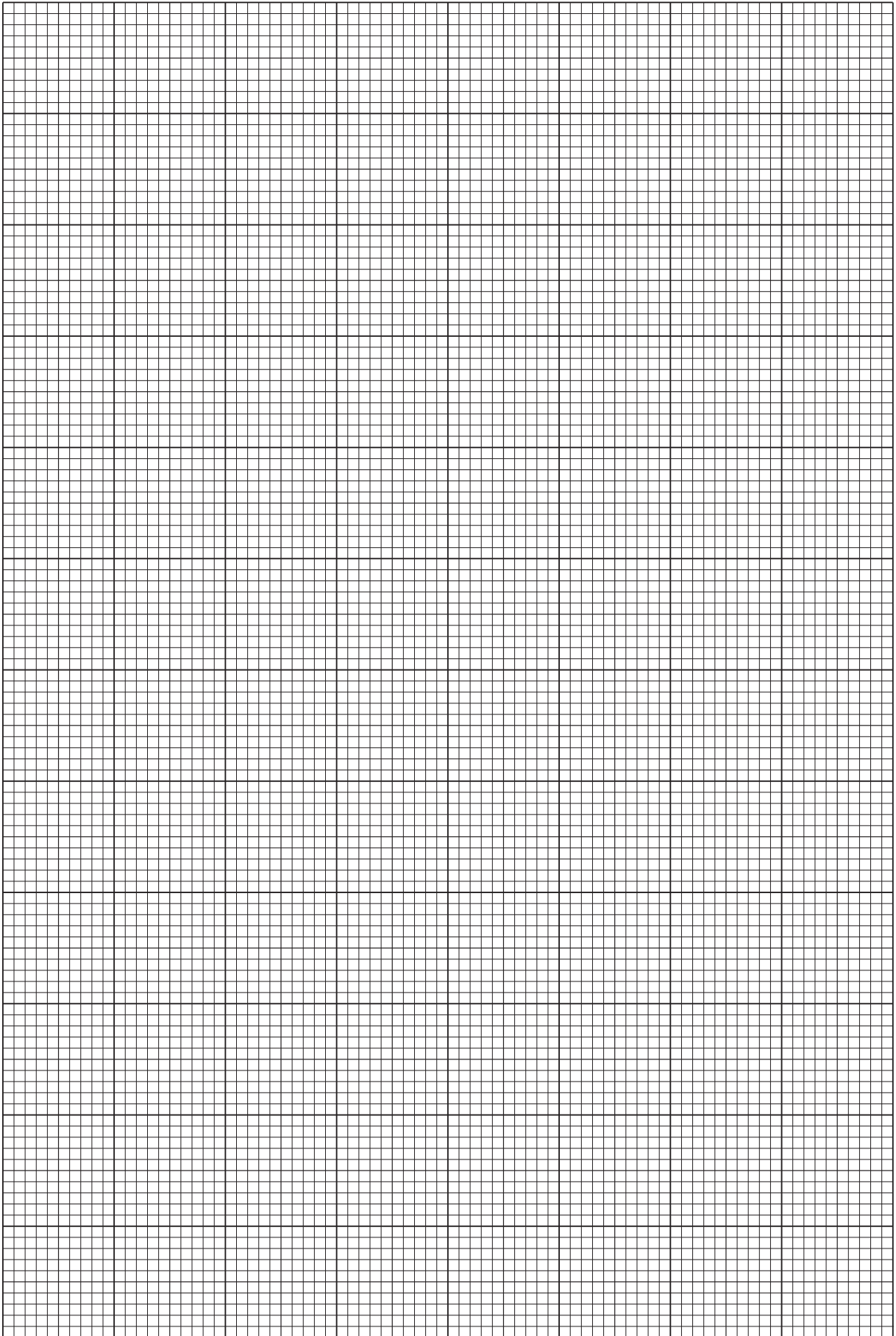
[1]

- (iii) Determine the gradient and y -intercept of this line.

gradient = ...

y -intercept = ...

[2]



(d) It is suggested that the quantities b , a and R are related by the equation

$$\frac{b}{a} = \frac{M}{R} + N$$

where M and N are constants.

Using your answers in (c)(iii), determine the values of M and N .
Give appropriate units.

$M =$

$N =$

[2]

[Total: 20]

You may not need to use all of the materials provided.

2 In this experiment, you will investigate the path of a jet of water.

(a) • Assemble the apparatus as shown in Fig. 2.1.

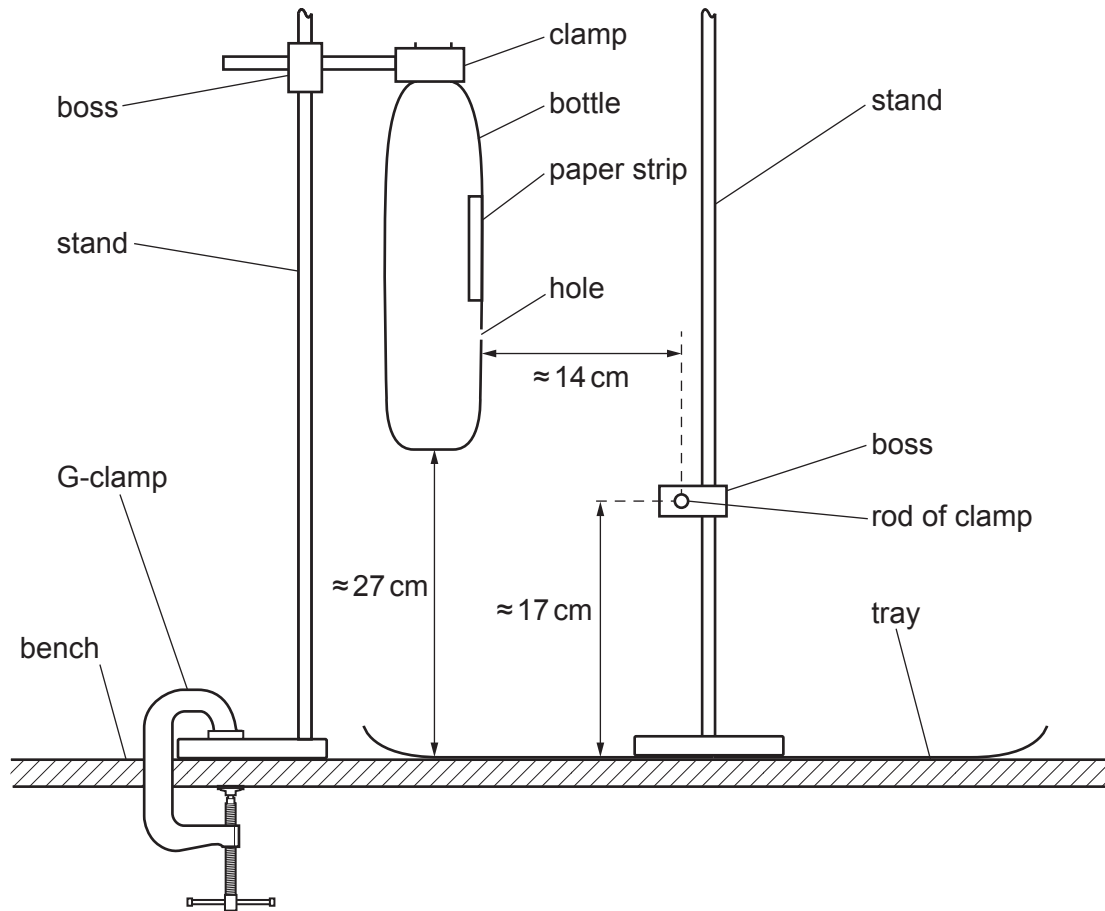


Fig. 2.1 (not to scale)

- Adjust the heights of the bosses so that the bottom of the bottle is approximately 27 cm above the tray and the rod of the clamp is approximately 17 cm above the tray.
- Move the stands so that the horizontal distance from the hole in the bottle to the rod of the clamp is approximately 14 cm, as shown in Fig. 2.1.

- The height of the centre of the hole above the tray is A . The distance from the centre of the hole to the centre of the rod is B . The height of the rod above the tray is C , as shown in Fig. 2.2.

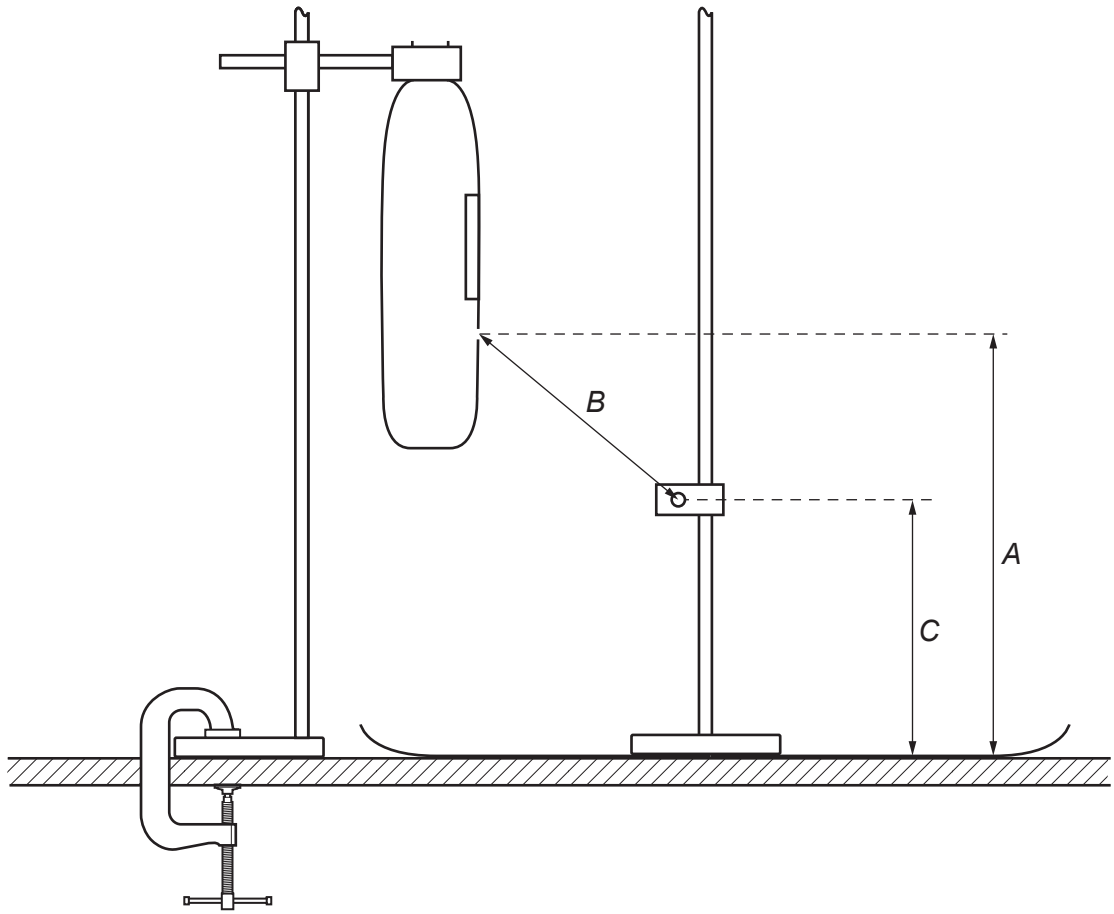


Fig. 2.2

Measure and record A , B and C .

$A =$ cm

$B =$ cm

$C =$ cm

- Calculate s using

$$s = A - C.$$

$s =$ cm

- Calculate x using

$$x = \sqrt{(B^2 - s^2)}.$$

$x =$ cm
[3]

- (b) (i)
- Position the empty jug under the rod.
 - Add water to the bottle until there is a jet of water passing over the rod, as shown in Fig. 2.3.

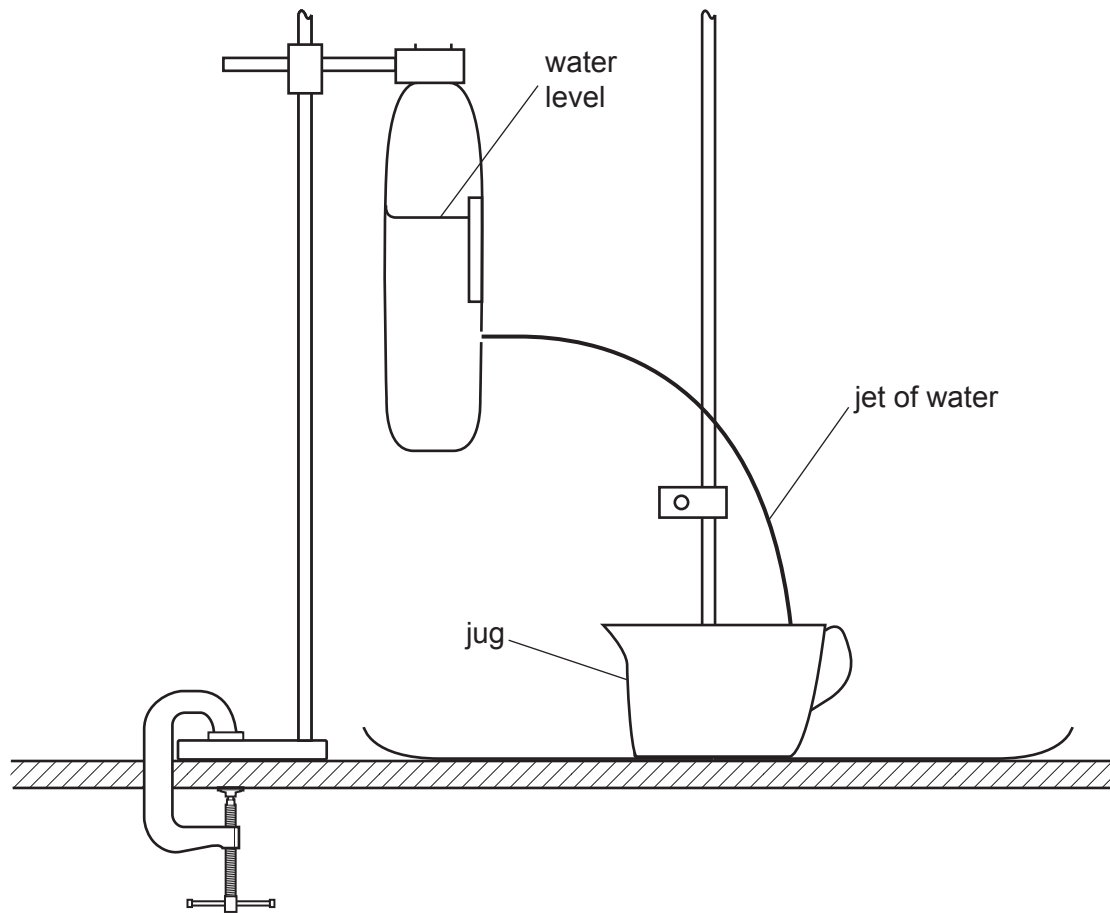


Fig. 2.3

- As the water level falls, the jet will get closer to the rod.

When the jet touches the rod, mark the water level on the paper strip, as shown in Fig. 2.4.

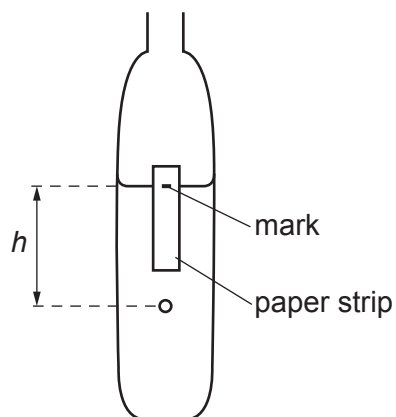


Fig. 2.4

- Measure and record the height h of the mark above the hole, as shown in Fig. 2.4.

$h = \dots\dots\dots$ [2]

- (ii) Estimate the percentage uncertainty in your value of h . Show your working.

percentage uncertainty = $\dots\dots\dots$ % [1]

- (c) • Increase the height of the bottom of the bottle above the tray to approximately 32 cm.
- Measure and record A and B .

$A = \dots\dots\dots$ cm

$B = \dots\dots\dots$ cm

- Calculate s and x .

$s = \dots\dots\dots$ cm

$x = \dots\dots\dots$ cm

- Repeat (b)(i).

$h = \dots\dots\dots$ [3]

- (d) It is suggested that the relationship between x , h and s is

$$kx = \sqrt{hs}$$

where k is a constant.

- (i) Using your data, calculate two values of k .

first value of k = ...

second value of k = ...

[1]

- (ii) Justify the number of significant figures that you have given for your values of k .

.....

.....

..... [1]

- (e) It is suggested that the percentage uncertainty in the values of k is 20%.

Using this uncertainty, explain whether your results support the relationship in (d).

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..... [1]

- (f) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

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- (ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

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9702/35

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October/November 2023

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1 In this experiment, you will determine the resistivity of a metal.

- (a) • Set up the circuit shown in Fig. 1.1.

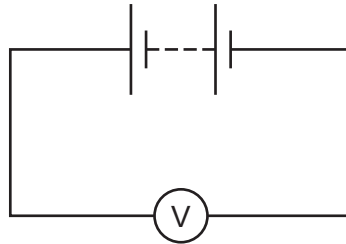


Fig. 1.1

- The voltmeter reading is E .

Record E .

$E = \dots\dots\dots$ V

- Set up the circuit shown in Fig. 1.2.

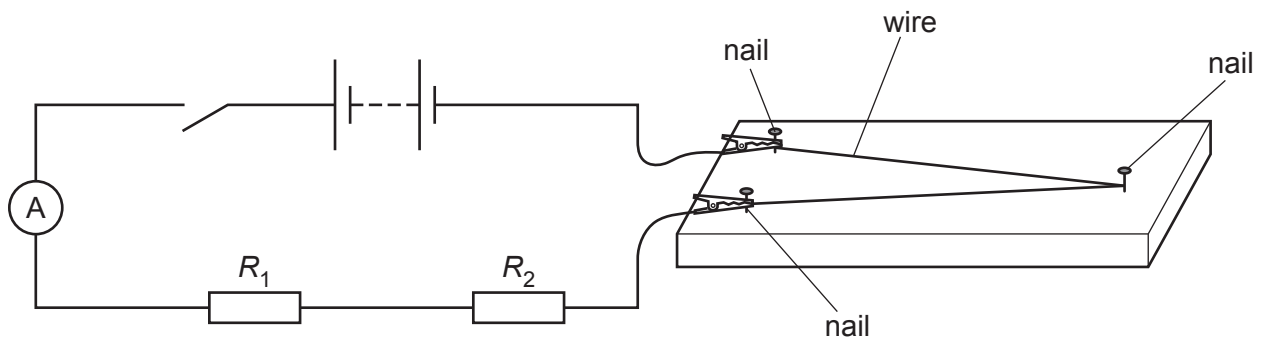


Fig. 1.2 (not to scale)

- You have been provided with several resistors, each with a different value of resistance. Select resistors and connect them so that $R_1 = 33\,\Omega$ and $R_2 = 56\,\Omega$.

- Record R_1 and R_2 .

$R_1 = \dots\dots\dots$

$R_2 = \dots\dots\dots$

- Calculate $(R_1 + R_2)$.

$(R_1 + R_2) = \dots\dots\dots$

- Close the switch.
- The ammeter reading is I .

Record I .

$I =$ mA

- Open the switch.

[1]

- (b) Change the values of R_1 and R_2 to provide six different values of $(R_1 + R_2)$.

For each arrangement, record values of R_1 , R_2 and I in a table. Include values of $(R_1 + R_2)$ and $\frac{1}{I}$ in your table.

[8]

- (c) (i) Plot a graph of $\frac{1}{I}$ on the y -axis against $(R_1 + R_2)$ on the x -axis.

[3]

- (ii) Draw the straight line of best fit.

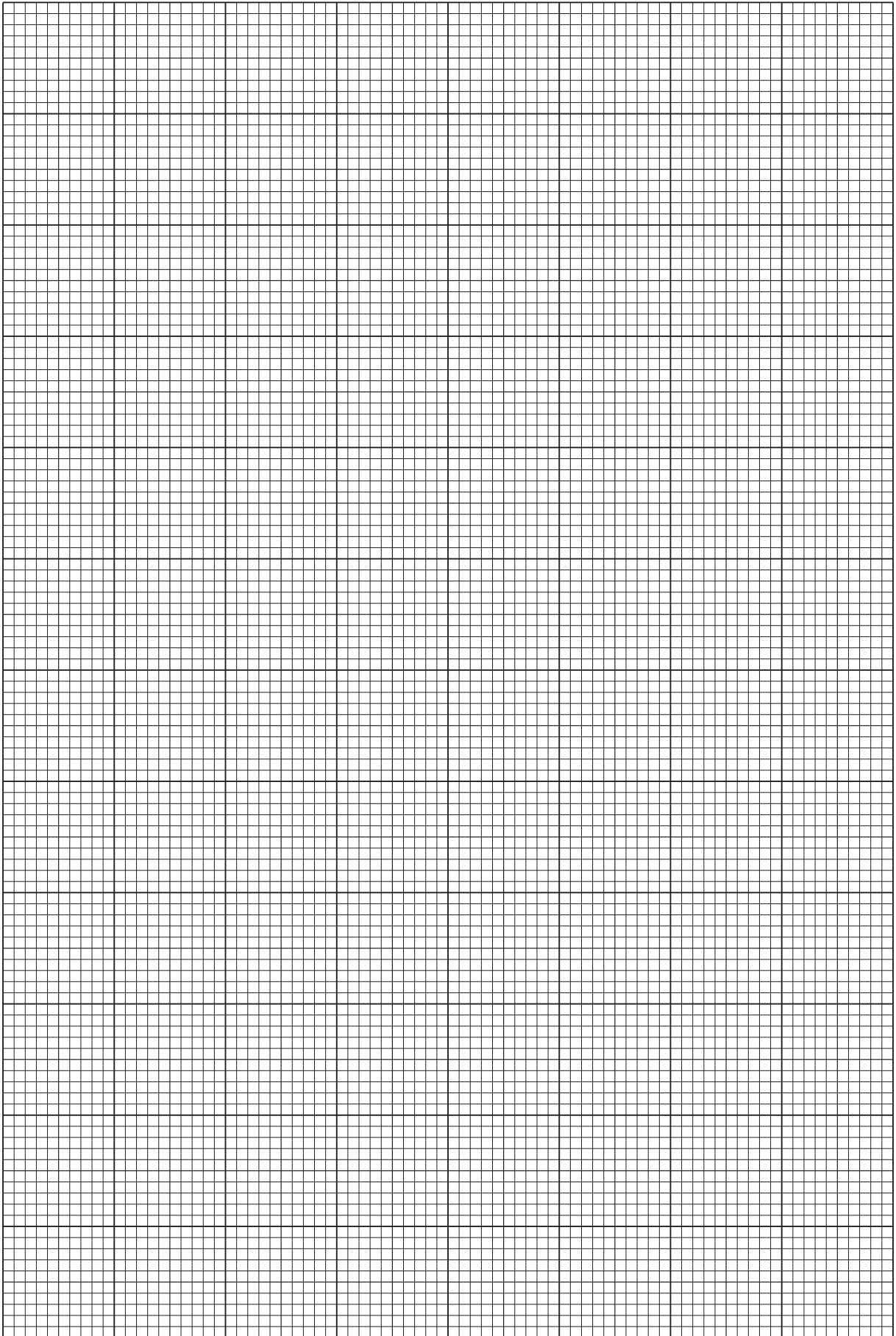
[1]

- (iii) Determine the gradient and y -intercept of this line.

gradient = ...

y -intercept = ...

[2]



- (d) It is suggested that the quantities I , R_1 and R_2 are related by the equation

$$\frac{1}{I} = F(R_1 + R_2) + G$$

where F and G are constants.

Using your answers in (c)(iii), determine the values of F and G .
Give appropriate units.

$$F = \dots\dots\dots$$

$$G = \dots\dots\dots [2]$$

- (e) (i) Use the micrometer to measure the diameter d of the wire.

$$d = \dots\dots\dots [2]$$

- (ii) It is suggested that G is given by the equation

$$G = \frac{4\rho L}{\pi d^2 E}$$

where L is 0.560 m and ρ is the resistivity of the metal of the wire.

Using your answers in (a), (d) and (e)(i), determine a value for ρ .

$$\rho = \dots\dots\dots \Omega \text{ m} [1]$$

[Total: 20]

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You may not need to use all of the materials provided.

2 In this experiment, you will investigate the movement of a mass hanger.

(a) You are provided with a number of paper clips.

Use the top-pan balance to determine the mass m of **one** paper clip.

$m = \dots\dots\dots$ g [1]

(b) (i) • Set up the apparatus as shown in Fig. 2.1.

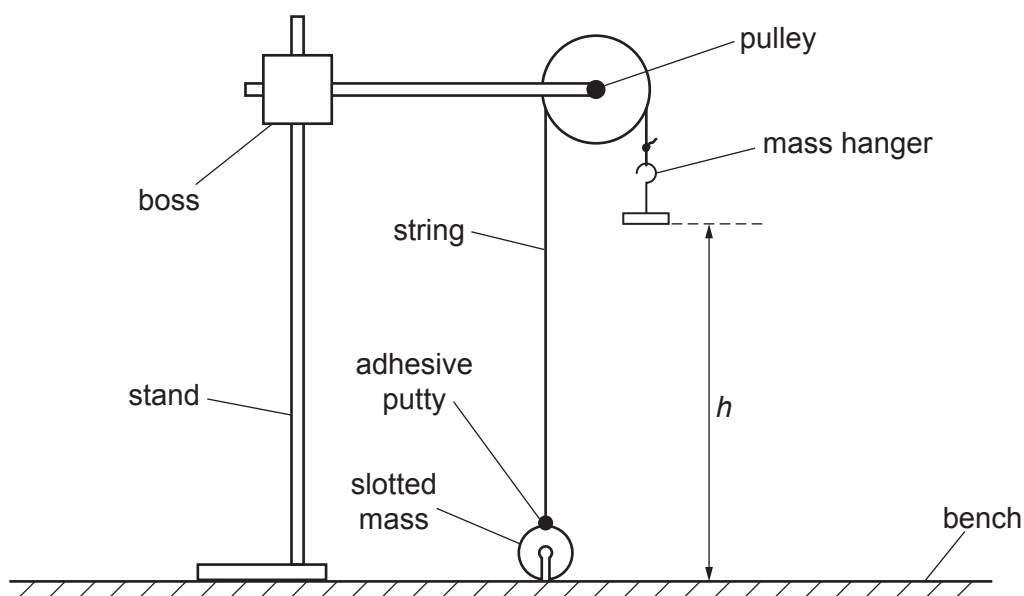


Fig. 2.1 (not to scale)

- Lower the slotted mass until it just touches the bench.
- The distance between the bottom of the mass hanger and the bench is h , as shown in Fig. 2.1.

Measure and record h .

$h = \dots\dots\dots$ cm [1]

- (ii) • Add just enough paper clips to the mass hanger so that it falls smoothly to the bench without stopping.
- Record the total number N of paper clips on the mass hanger.

$N = \dots\dots\dots$ [1]

- (iii) • Adjust the position of the slotted mass so that it is just touching the bench again.
- Release the slotted mass and measure the time t for the mass hanger and N paper clips to fall to the bench.

$t = \dots\dots\dots$ [2]

- (iv) Estimate the percentage uncertainty in your value of t . Show your working.

percentage uncertainty = $\dots\dots\dots$ % [1]

- (v) The acceleration a of the mass hanger is given by the relationship

$$a = \frac{2h}{t^2}.$$

Calculate a .

$a = \dots\dots\dots \text{cms}^{-2}$ [1]

- (vi) Justify the number of significant figures that you have given for your value of a .

$\dots\dots\dots$

$\dots\dots\dots$

$\dots\dots\dots$ [1]

- (c) • Add two more paper clips to the mass hanger.
- Record the total number N of paper clips on the mass hanger.

$N =$

- Repeat **(b)(iii)** and **(b)(v)**.

$t =$

$a =$ cm s^{-2}
[2]

- (d) It is suggested that the relationship between a , m and N is

$$\frac{k}{a} = 1 + \frac{2Z}{Nm}$$

where Z is the mass of the slotted mass and has the value 10.0 g, and k is a constant.

Using your data, calculate two values of k .

first value of $k =$

second value of $k =$
[1]

(e) It is suggested that the percentage uncertainty in the values of k is 25%.

Using this uncertainty, explain whether your results support the relationship in (d).

.....

.....

.....

..... [1]

- (f) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

1

.....

2

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3

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4

.....

[4]

- (ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

1

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[4]

[Total: 20]

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PHYSICS

9702/36

Paper 3 Advanced Practical Skills 2

October/November 2023

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You will be allowed to work with the apparatus for a maximum of 1 hour for each question.
- You should record all your observations in the spaces provided in the question paper as soon as these observations are made.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [].

For Examiner's Use

1	
2	
Total	

This document has **12** pages. Any blank pages are indicated.

You may not need to use all of the materials provided.

1 In this experiment, you will investigate an electrical circuit.

(a) • Connect the circuit shown in Fig. 1.1.

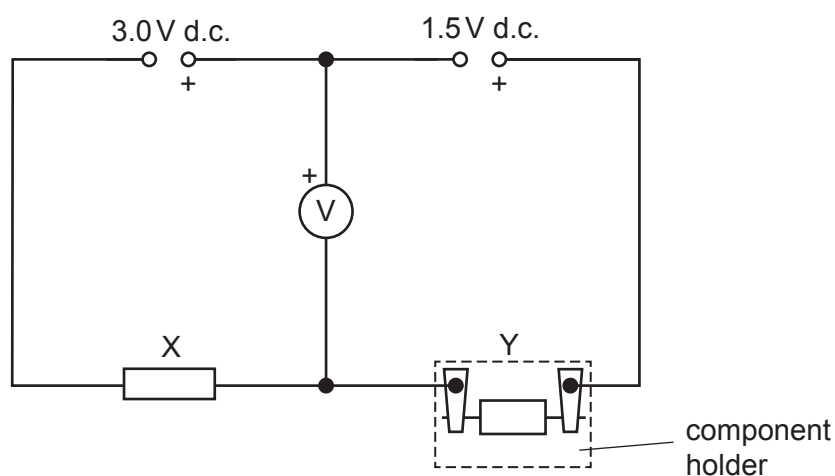


Fig. 1.1

- Ensure that the polarities of the two power supplies and the voltmeter are as shown in Fig. 1.1.
- Connect one of the labelled resistors into the component holder as resistor Y, as shown in Fig. 1.1. Record the resistance R of resistor Y.

$R =$

- The voltmeter reading should be approximately 3 V.

Record the voltmeter reading V .

$V =$

[2]

- (b) Change Y and record R and V . Repeat until you have six sets of values of R and V .

Record your results in a table. Include values of $\frac{1}{R}$ in your table.

[10]

- (c) (i) Plot a graph of V on the y -axis against $\frac{1}{R}$ on the x -axis.

[3]

- (ii) Draw the straight line of best fit.

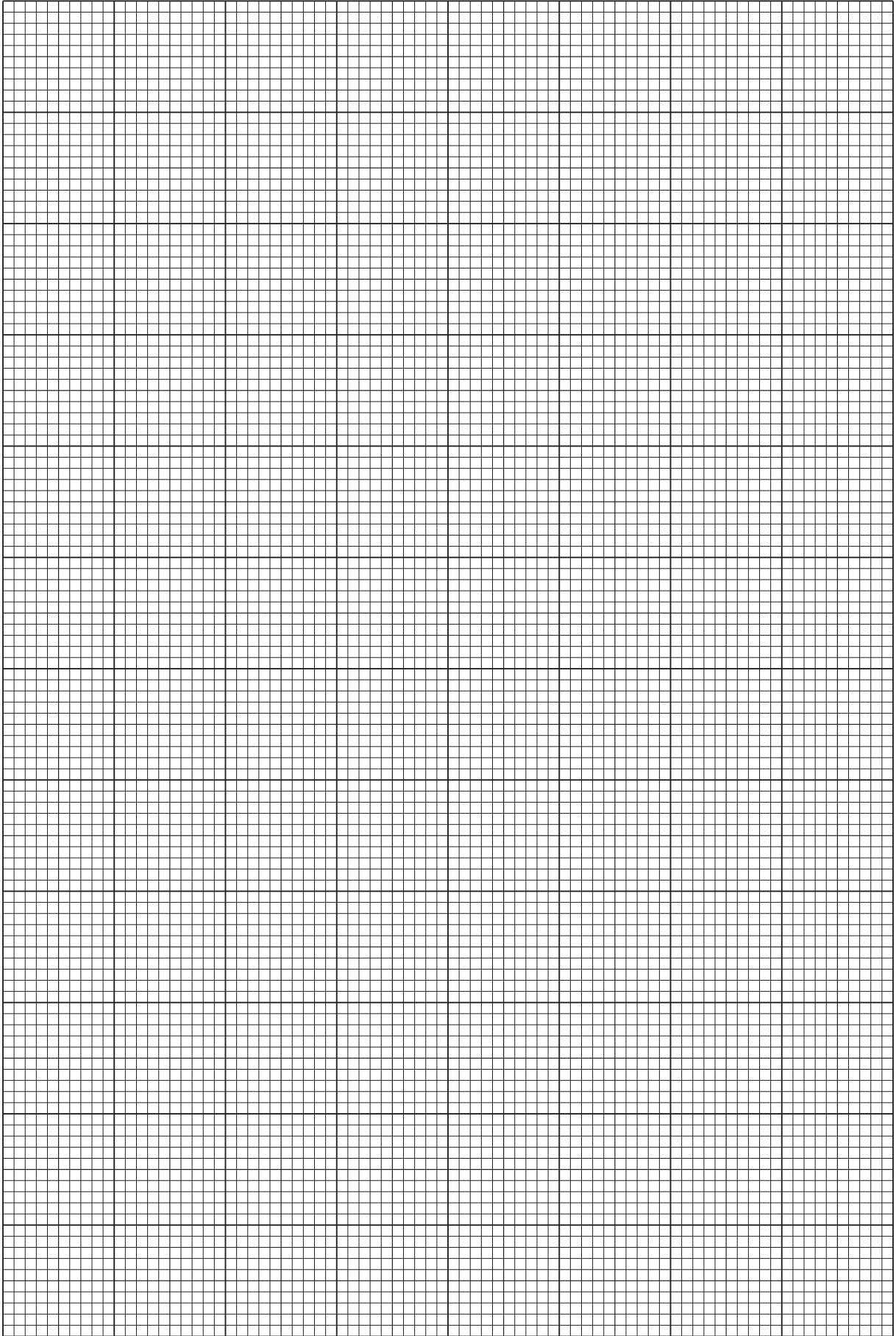
[1]

- (iii) Determine the gradient and y -intercept of this line.

gradient = ...

y -intercept = ...

[2]



(d) It is suggested that the quantities V and R are related by the equation

$$V = \frac{a}{R} + b$$

where a and b are constants.

Using your answers in (c)(iii), determine the values of a and b .

Give appropriate units.

$a =$

$b =$

[2]

[Total: 20]

You may not need to use all of the materials provided.

- 2** In this experiment, you will investigate the properties of linked rubber bands.

You are provided with two elastic strings made from linked rubber bands. The longer one is made from three rubber bands and the shorter one is made from two rubber bands. Each string has a 50 g mass attached to one end.

- (a)** Measure and record the unstretched length l_0 of the **longer** elastic string, as shown in Fig. 2.1.

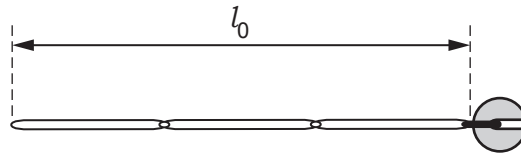


Fig. 2.1

$l_0 = \dots\dots\dots$ cm [1]

- (b)** • Assemble the apparatus as shown in Fig. 2.2 using the **longer** elastic string and with the clip approximately 40 cm above the pad of paper.

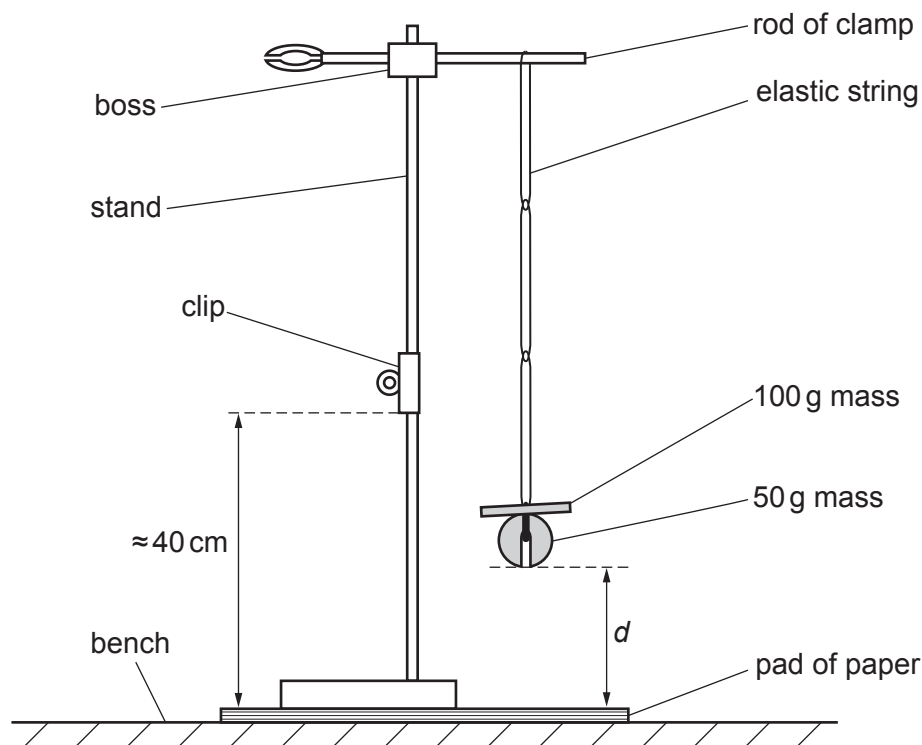


Fig. 2.2

- The distance between the bottom of the 50 g mass and the pad is d . Adjust the boss until d is approximately 2 cm.
- Measure and record d .

$d = \dots\dots\dots$ cm

- Remove the 100 g mass from the elastic string, as shown in Fig. 2.3.

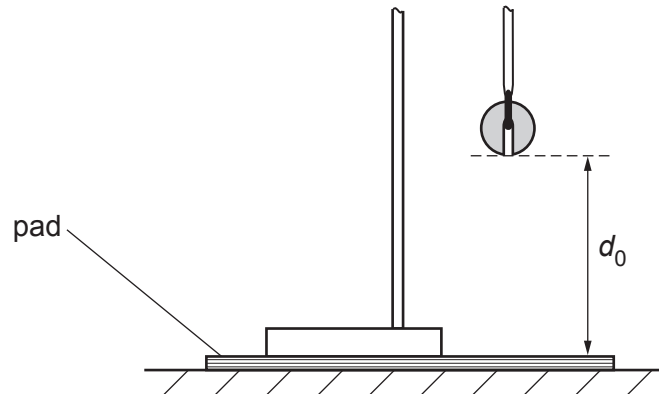


Fig. 2.3

- Measure and record the distance d_0 between the bottom of the 50 g mass and the pad.

$d_0 = \dots\dots\dots$ cm
[2]

- (c) (i) • Using your hand, raise the 50 g mass until the bottom of the mass is level with the bottom of the clip, as shown in Fig. 2.4.

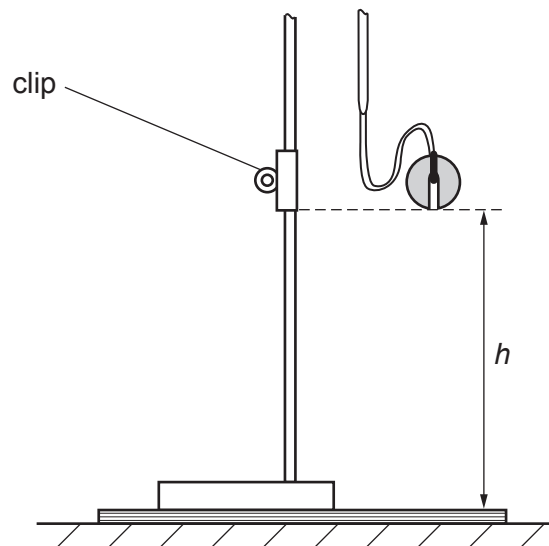


Fig. 2.4

- Release the mass and watch (and listen) to see if it **just** touches the pad. If it doesn't **just** touch the pad, change the position of the clip and repeat the process. Continue until the mass **just** touches the pad.
- Measure and record the vertical height h of the bottom of the clip above the pad, as shown in Fig. 2.4.

$h = \dots\dots\dots$ cm [1]

- (ii) Estimate the percentage uncertainty in your value of h . Show your working.

percentage uncertainty = ... % [1]

- (iii) • Using your hand, pull the 50 g mass down until it is just touching the pad, as shown in Fig. 2.5.

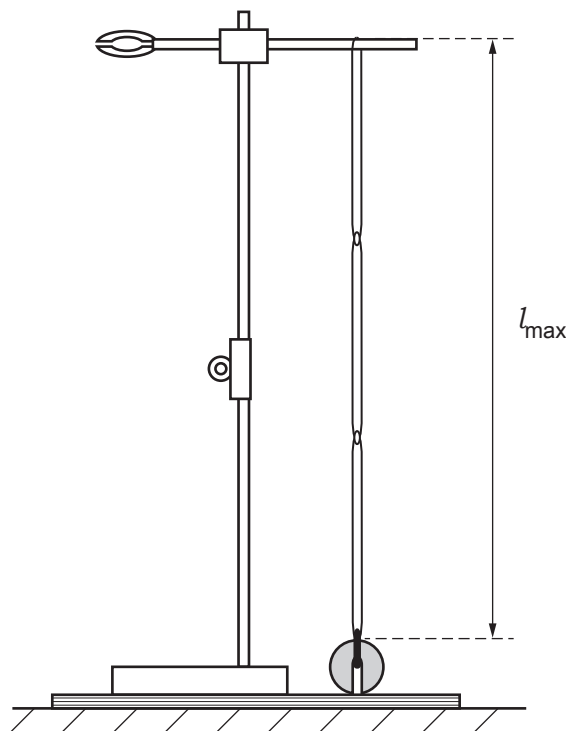


Fig. 2.5

- Measure and record the length $l_{\max}$ of the elastic string, as shown in Fig. 2.5.

$l_{\max} = \dots\dots\dots$ cm [1]

(d) Repeat (a), (b), (c)(i) and (c)(iii) using the **shorter** elastic string.

$$l_0 = \dots\dots\dots \text{ cm}$$

$$d = \dots\dots\dots \text{ cm}$$

$$d_0 = \dots\dots\dots \text{ cm}$$

$$h = \dots\dots\dots \text{ cm}$$

$$l_{\text{max}} = \dots\dots\dots \text{ cm}$$

[3]

- (e) It is suggested that the relationship between $l_{\max}$, l_0 , h , d_0 and d is

$$(l_{\max} - l_0)^2 = Ch(d_0 - d)$$

where C is a constant.

- (i) Using your data, calculate two values of C .

first value of $C = \dots\dots\dots$

second value of $C = \dots\dots\dots$

[1]

- (ii) Justify the number of significant figures that you have given for your values of C .

.....

.....

..... [1]

- (f) It is suggested that the percentage uncertainty in the values of C is 15%.

Using this uncertainty, explain whether your results support the relationship in (e).

.....

.....

.....

..... [1]

- (g) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

- 1
-
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[4]

- (ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

- 1
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[4]

[Total: 20]

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